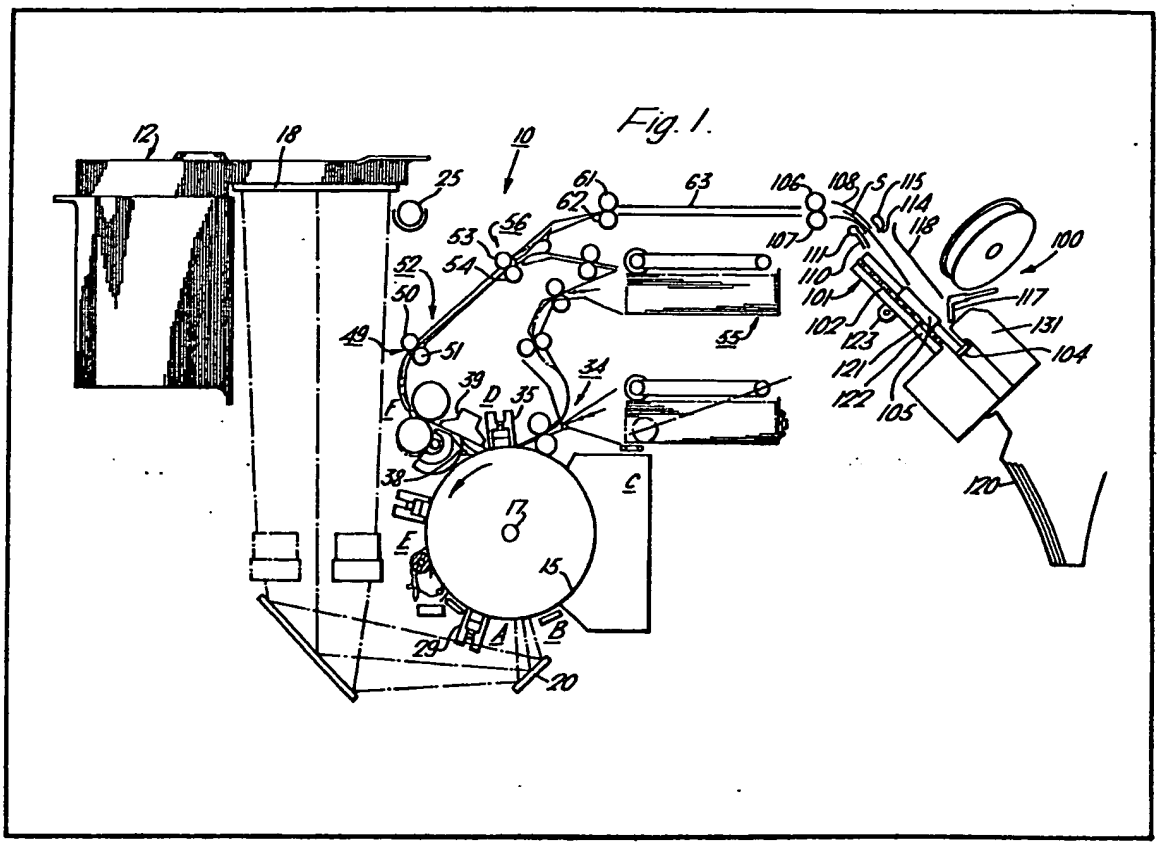
(12) UK Patent Application (19) GB (11) 2 032 889 A

(21) Application No 7843432
(22) Date of filing 7 Nov 1978
(23) Claims filed 7 Nov 1978
(43) Application published 14 May 1980
(51) INT CL³ B65H 29/24
(52) Domestic classification B8R 611 613 621 671 SS
(56) Documents cited GB 296328
(58) Field of search B8R
(71) Applicant Xerox Corporation, Xerox Square, Rochester, New York, United States of America
(72) Inventors Edric Raymond Brooke, Brian David Dunbar Berry, Raghulinga R. Thettu
(74) Agent N. J. Prior

(54) **Improvements in Sheet Handling**

(57) The invention is concerned with sheet handling and more particularly to the stacking of sheets in corner registration. Apparatus is described which comprises a support surface 102 inclined downwardly towards at least one of two registration stops 104, 105 defining a registration corner. Air is directed across the surface 102 from orifices 110 arranged at the upper end of the surface and beneath the sheet delivery path and spaced across said path to assist in corner registration. Additionally, air jets from nozzles 114 may direct the sheets towards the corner. The support surface may also be skewed in the delivery plane. The stop 105 may be retractable to facilitate stack removal, during which air may be blown through perforations in the surface to reduce friction.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.



GB 2 032 889 A

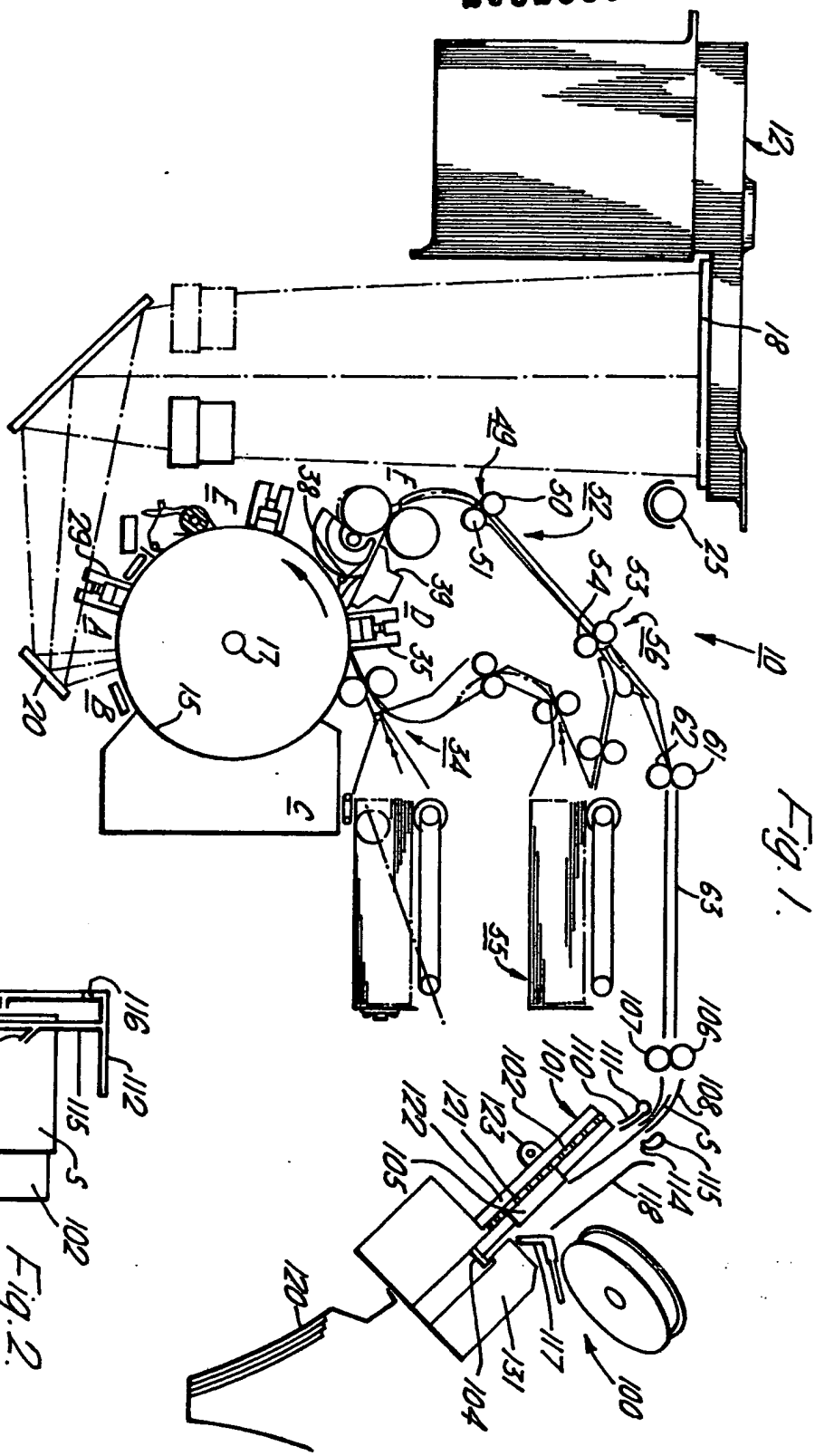


Fig. 1.

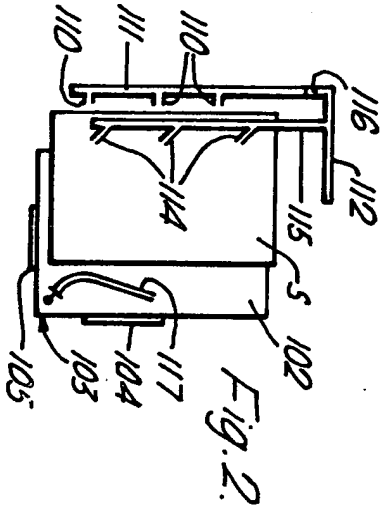
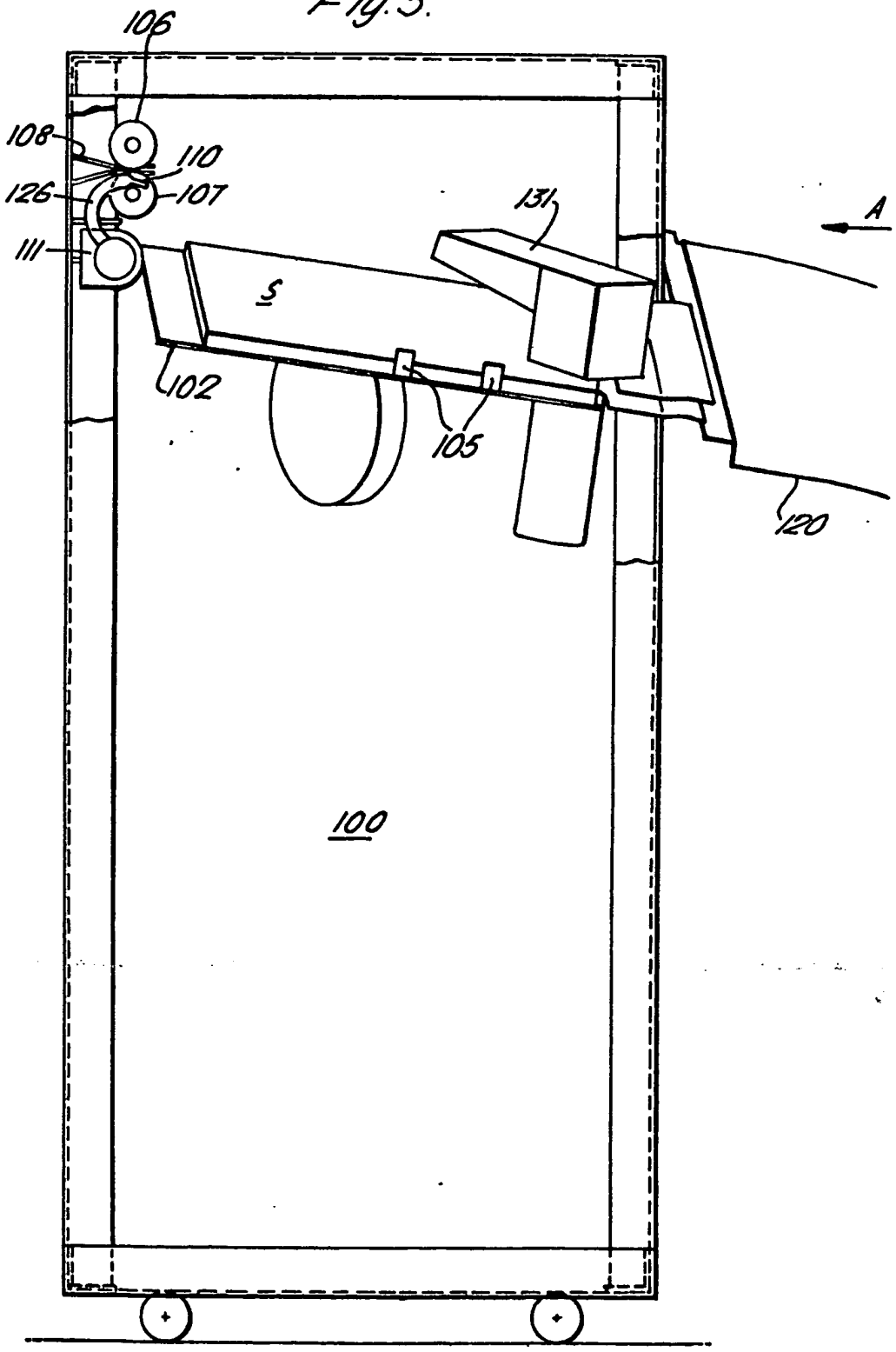


Fig. 2.

Fig. 3.



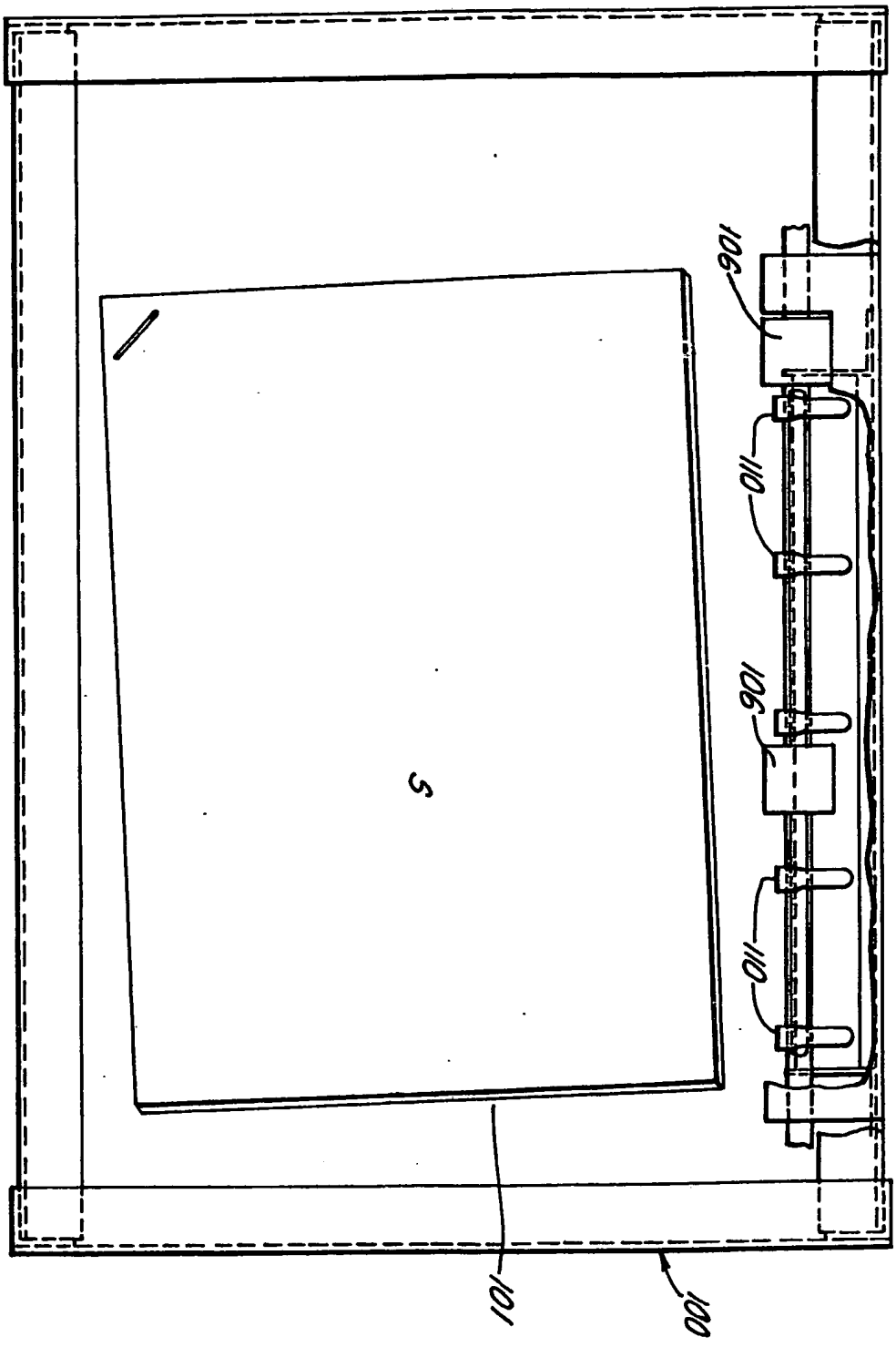


Fig. 4.

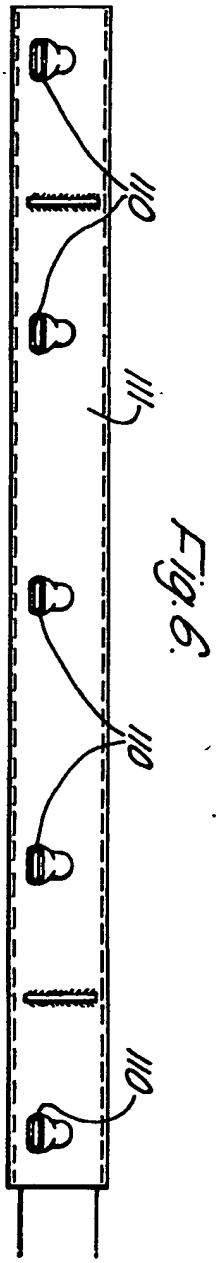

110
111
110
111

Fig.6.

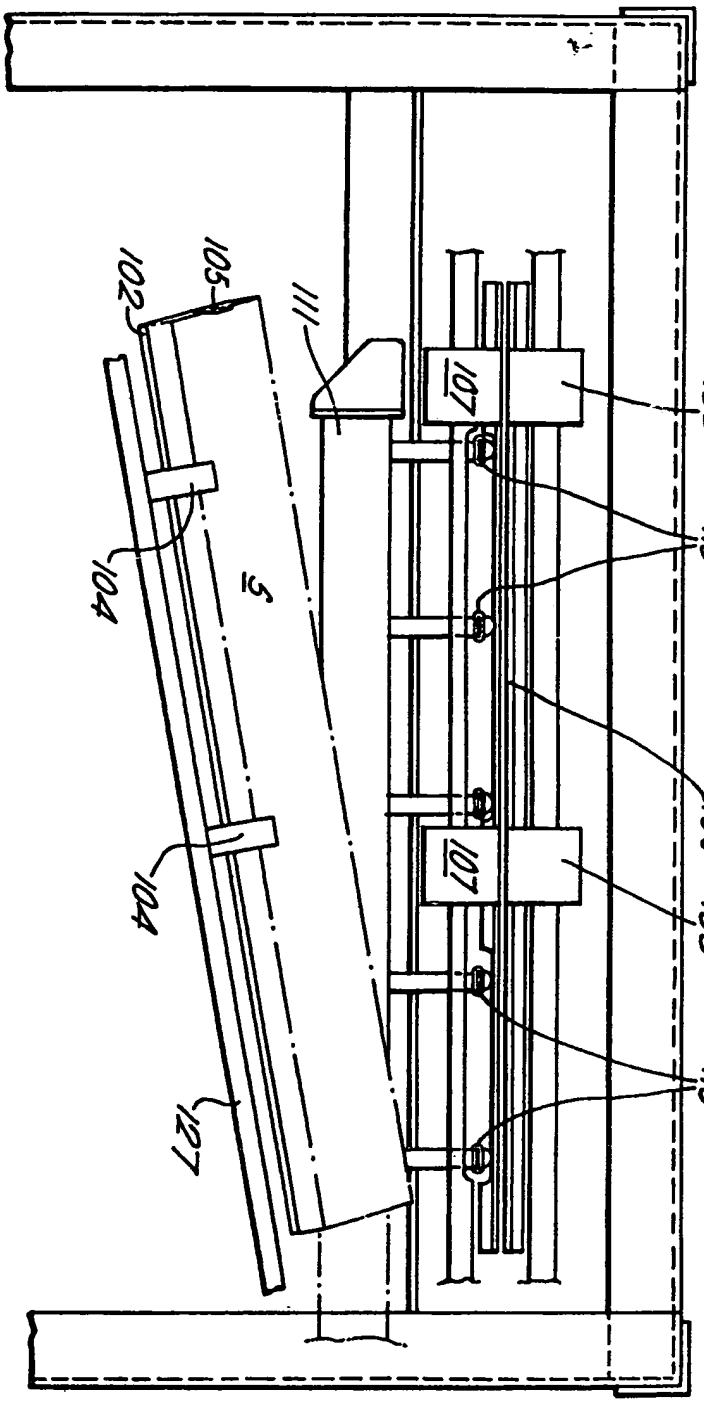

105
102
111
107
106
110
104
S
108
104
107
106
127
110

Fig.5.

SPECIFICATION

Improvements in Sheet Handling

This invention relates to sheet handling and more particularly to sheet stacking apparatus and methods.

Stacking apparatus typically act on sheets fed serially thereto to stack the sheets in registration with each other so as to provide an attractive and compact stack or signature with uniform edges. For complete registration the sheets used to be aligned both laterally and longitudinally. This may be achieved by registering two adjacent edges (one end and one side) of the sheet with respect to respective registration stops and this form of registration is termed corner registration.

Stacking apparatus may be required in addition to compiling the sheets into sets to position the sheets with respect to a fixed finishing device such as a stitcher, stapler or punch. This is readily achieved by corner registration.

This invention is particularly concerned with corner registration apparatus utilizing air flow.

The use of air in sheet handling systems is well known and has been employed both for transporting sheets and for guiding sheets against registration devices. Thus, in U.S. Patent No. 3,556,515 a collating machine is provided with a guide channel along which sheets are advanced by pins on an endless conveyor and air is blown through the floor of the channel to support the sheets as they are being advanced and reduce friction effects.

A pneumatic sheet transport and alignment mechanism is disclosed in U.S. Patent No. 3,918,706 in which a pneumatic transport causes sheets to be moved laterally to engage an edge guide such that the sheet is properly aligned for subsequent operations upon exiting from the transport and alignment mechanism. Here the sheet is restrained in a sleeve between top and bottom guides and air is blown against the sheet faces through orifices angled to direct the sheet progressively to one side. Another pneumatic sheet registration apparatus employing a guide sleeve is described in U.S. Patent No. 4,090,704. The sleeve has one end open and air is blown in through the open end where the sheet enters and exits through orifices in the opposite closed end and one side of the sleeve to provide corner registration. The closed end of the sleeve is retractable to permit removal of a registered sheet. This principle is extended in U.S. Patent No. 4,116,431 to the handling of sheet stacks.

In U.S. Patent No. 3,503,607 there is described a pneumatic stacker mechanism for a document feeder. Documents transported down the document feeder path encounter a series of reverse direction fluid jets located behind the exit point of the feeder mechanism. The reverse direction jets arrest the document motion and start the document back toward the feeder exit point. A document deflection jet means associated with the reverse direction jets deflects the document downwardly toward a stacker receptacle and the reverse direction jets together with the deflection jet means then act on the document to quickely force the document into the stacker receptacle. A fluid jet curtain located above the stacker receptacle acts to assist the reverse direction jets in guiding the document into the stacker receptacle.

U.S. Patent No. 3,971,554 describes a pneumatic sheet stacker where individual sheets are inserted between the preceding sheet and an air flotation chamber having angled ports for discharge of air in the direction of sheet movement to transport the sheet between the preceding sheet and the chamber, maintain the delivered sheets out of the path of incoming sheets, and hold the delivered sheets in a planar condition. The chamber may be arranged on top of or underneath the stack.

It is an object of the present invention to provide a stacking apparatus and method for corner registering sheets.

It is a further object of the invention to provide such apparatus in which the effects of intersheet friction are alleviated or minimised.

From one aspect, the invention provides apparatus for stacking sheets in corner registration on a support surface in which sheets are delivered serially to the stack support surface and directed in a registration corner, said support surface defining a stack supporting area adjacent the registration corner and inclined in the direction of sheet travel, wherein means is arranged upstream of said stack supporting area and beneath the sheet delivery path to produce a flow of air over the stack supporting area at least partially to support each sheet being stacked during registration.

By directing air under the sheets as they are entering the stack supporting area and being registered, the sheets are able to glide over the stack (or in the case of the first sheet of the set, the support surface) with a reduced resistance due to electrostatic or friction drag.

The air flow is preferably produced by a plurality of air jets issuing from orifices arranged across the sheet delivery path adjacent the entrance to the support surface. The jets are suitably shaped to produce a thin layer or blanket of air flowing across the stack supporting surface. Advantageously the jets are aimed downwardly towards the support surface to impinge on the latter within the stack supporting area, preferably about half way across the stack supporting area. In order to avoid fluffing of the stacked sheets, the height of the orifices relative to the stack support and the angle of the jets should be chosen so that within the intended range of stack heights the jets do not impinge against the edge of the stack.

It will be understood that depending upon the spacing and/or shape of the orifices, the air flow may comprise separate streams or the streams of the individual orifices may combine to produce a continuous stream of air.

The sheets may be directed into the registration corner in various ways. For example,

the support surface may be inclined downwardly at a compound angle towards the registration corner. Or air jets arranged above the sheet delivery path may be aimed to direct the sheet towards the registration corner. Or the sheet supporting air flow may itself provide a component of force directed towards the registration corner. These sheet directing means may be used either alone or in combination. Thus, in a preferred form both the compound tilting of the support surface and the direction jets are utilised.

Instead of or in addition to giving a compound tilt to the support surface as described above the surface may be skewed at an angle to the sheet delivery path thus assisting further in corner registration where the sheets may tend to skew during registration.

Furthermore, if desired, one or more air jets may be arranged aimed at and adjacent to the registration corner and/or registration edges to alleviate sheet bounce as the sheets are registered, thus permitting the achievement of higher sheet feed rates.

The registration corner is suitably formed by separate end and side registration stops although the stops may be constituted by a single member if preferred. At least one of the stops may be retractable for removing the compiled sets. In order to assist in removing the compiled sets the support surface may be formed with an array of apertures through which air may be blown during set removal to support the set on a cushion of air. The apparatus suitably includes at least one binding device, e.g. stapler or stitcher, for binding sets compiled on the support surface.

From another aspect, the invention provides, in apparatus for stacking in corner registration on a support surface sheets delivered serially thereto, the support surface being inclined downwardly towards at least one of two registration stops defining a registration corner, a plurality of air jets arranged at the upper end of said surface beneath the sheet delivery path to direct air across said surface to assist in corner registration.

From another apsect, the invention provides a method for stacking sheets in corner registration on a support surface comprising delivering sheets serially to the support surface and directing the sheets into a registration corner, wherein air is directed from one or more positions upstream of the stack and beneath the sheet delivery path to form a cushion of air beneath each sheet as it is being conveyed onto the stack at least partially to support each sheet being stacked during registration.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:—

Figure 1 is a schematic side elevation of an exemplary form of photocopier incorporating one embodiment of sheet stacker of this invention,

Figure 2 is a plan view showing the principle of operation of the stacker.

Figure 3 is a schematic side elevation of a second embodiment of sheet stacker according to the invention,

Figure 4 is a plan view of the stacker shown in Figure 3 with certain parts removed for clarity,

Figure 5 is a view of the stacker shown in Figure 3 looking in the direction of Arrow A with parts removed for clarity, and

Figure 6 shows an array of flotation orifices suitable for use in the embodiment of Figure 1.

Referring to Figure 1 there is shown an automatic xerographic reproducing machine 10 incorporating a sheet stacker 100 according to this invention. The copying machine 10 is capable of producing either simplex or duplex copies in sets from a wide variety of originals which may be advanced in recirculating fashion by recirculating document apparatus 12 described in U.S. Patent No. 3,556,512. Although the present invention is particulary well suited for use in automatic xerography, the apparatus generally designated 100 is equally well adapted for use in any number of devices in which cut sheets of material are delivered in a set or stack and the set then separated from a previous set and forwarded to an output tray.

The processor 10 includes a photosensitive plate in the shape of a drum 15 mounted on a shaft 17 journalled for rotation in the machine frame. The xerographic drum is rotated in the direction indicated so as to pass sequentially through a series of xerographic processing stations.

A document to be reproduced is transported by document handling apparatus 12 from the bottom of a stack to a platen 18 and scanned by means of a moving optical scanning system to produce a flowing light image on the drum at B. After scanning, the document is returned and the next advanced and scanned and so on until the entire document stack has been copied at which time the cycle may be repeated as described in the above patent. Prior to the imaging of the drum surface, the drum is first uniformly charged by means of a corona generator 29 at charging station A.

The latent electrostatic image formed by exposing the charged drum, is carried past developer station C where it is developed into visible form and the developed image is carried to a transfer station D where it is transferred to cut sheets of paper moved into the transfer station from sheet registering apparatus 34 in synchronous relation with the image on the drum surface. The copy sheet is stripped from the drum surface by a stripper finger 38 and directed into contact with a stationary vacuum transport 39 leading to a fusing station F. Residual toner remaining on the drum surface after transfer is removed at a cleaning station E).

Upon leaving the fuser, the fixed copy sheet is passed through a curvilinear sheet guide system, generally referred to as 49, incorporating advancing rolls 50 and 51. The advancing rolls forward the sheet through a linear sheet guide system 52 and to a second pair of advancing

rollers 53 and 54. At this point, depending on whether simplex or duplex copies are desired, the simplex copy sheet is either forwarded directly to the stacker 100 via pinch rolls 61, 62 or into upper supply tray 55 by means of a movable sheet guide 56 before the finishing apparatus for the duplexed copy. Movable sheet guide 56, and associated advancing rolls are prepositioned by appropriate machine logic system to direct the individual sheets into the desired path.

The stacking apparatus 100 comprises a tray 101 having a base or support surface 102 inclined downwardly in the direction of sheet travel towards a registration corner 103 (Fig. 2) defined by registration fences 104, 105 extending along the lower edge and one side of the tray. Above the upper end of the support surface is arranged a pair of coacting sheet feed rolls 106, 107 arranged to receive sheets fed along path 63 by pinch rolls 61, 62. From the feed rolls 106, 107, a sheet is directed by guide throat 108 towards the tray 101.

An array of orifices 110 mounted on a manifold 111 are arranged across the sheet delivery path beneath the throat 108 adjacent the entrance to the tray 101. Air is supplied under pressure to the manifold via line 112 and the orifices are so shaped and directed that the flotation jets issuing therefrom produce a thin layer or blanket of air flowing across the support surface 102. As shown in Figure 1, the orifices 110 are aimed downwardly towards the surface so that the flotation jets impinge on it about half way down. In order to avoid fluffing of the stacked sheets, the height of the orifices 110 relative to the stack support and the angle of the orifices are chosen so that the flotation jets are aimed beyond the rear edge of the highest stack of the smallest sheets for which the apparatus is designed.

A second array of orifices 114 is arranged above the sheet feed throat 108 to produce directional air jets aimed as shown in Figure 2 to direct the sheets being stacked towards the registration corner 103. These orifices are mounted on a manifold 115 which like the manifold 111 is connected to supply line 112. The directional jets issuing from orifices 114 are suitably at a higher pressure than the flotation jets issuing from orifices 110, the latter ideally being high volume, low pressure jets, and a flow reducing valve is provided in line 112 at 116. Thus, while the orifices 114 are constructed as small diameter high pressure nozzles, the orifices 110 are, as shown in Figure 6 for example, relatively large and shaped to produce a flat spreading flow of air.

For a three jet sheet flotation device as shown in Figure 1, the air is preferably supplied at between 40 and 60 litres/minute at a pressure of between 10 and 20 millibars. For a five jet system as shown in Figures 3 to 5 and 6 to a flow of between 80 and 120 litres/minute at a pressure of between 3 and 5 millibars has been found suitable.

A further retard jet issuing from orifice 117 located close to the registration corner and aimed into the corner prevents or reduces sheet bounce as the sheets strike the registration fences. This jet further serves to assist the directional jets in corner registering the sheets S as the latter come beneath it. The provision of one or more retard jets as illustrated, by reducing or eliminating sheet bounce, reduces the registration time and permits the achievement of higher copy feed rates.

A wire sheet guide 118 may be arranged over the stacking surface.

In operation, sheets S fed along path 63 pass through guide throat 108 and as they exit therefrom are acted upon by the directional air jets from orifices 114 and the flotation jets from orifices 110. The former serve to guide the sheets towards the side registration fence 105 as the sheet moves across the downwardly inclined surface 102 or the stack already thereon. This guiding movement produced by gravity and the directional jets is assisted by the flotation jets which form an air blanket under the sheet allowing it to glide over the surface/stack without resistance due to electrostatic or friction drag. As the sheet becomes corner registered, with the added assistance of the retard jets, the rear end of the sheet passes through the flotation air blanket and all the jets tend to hold the sheet in its registered position.

After the required number of sheets has been compiled into a set in the tray 101, the set may be bound, such as by insertion of a corner staple or stitch by a binding device schematically represented at 131. Completed sets may be collected in output tray 120 and for ejecting set into the tray 120 the fence 104 is retractable. For example the fence may be supported from a rotatable shaft in the manner shown in U.S. Patent 4,090,704.

In order to reduce the effects of friction and electrostatic drag between the stack and the support surface 102 during set ejection, the latter is perforated with an array of apertures 121 through which, during set ejection, air is blown from plenum 122 supplied with air under pressure through line 123.

In the embodiment illustrated in Figures 1 and 2, the support surface 102 is directed downwardly in the direction of sheet travel, i.e. towards the end registration stop 104, and the sheets are directed towards the registration corner by the directional jets issuing from orifices 114. In the embodiment illustrated in Figures 3 to 5 on the other hand the orifices 114 are omitted and the sheets are directed into the registration corner by gravity. This is achieved by tilting the tray 102 at a compound angle whereby the tray is not only tilted downwardly towards the end registration stop 104 but is also tilted downwardly towards the side registration stop 105 as shown in Figure 5. Additionally, the tray is rotated in a horizontal plane so that the support surface is skewed relative to the direction of sheet travel through a small angle. This skew corresponds to the natural skew of the sheets as

they glide across the compound tilted tray towards the registration corner and will depend on the compound angle of tilt of the tray. The angle C of tilt in the direction of sheet travel is suitably between 7 and 20 degrees to the horizontal and the angle B of the tilt towards the side registration stop is suitably between 7 and 15 degrees while the skew angle A is between 2 and 10 degrees, preferably being kept as small as possible.

In this embodiment the stacking apparatus is formed as a separate module which may be attached to the output end of a copier. The apparatus incorporates feed rolls 106, 107 and the flotation jet orifices 110 are located between the feed rolls at the ends of swan's neck pipes 126, the manifold 111 being arranged underneath rolls 107. The registration stops 104, 105 are formed by pairs of tabs and the stop 104 is mounted on a shaft 127 (Fig. 5) which may be rotated to retract the stop during set ejection. Set ejection into the output tray 120 may be effected in any desired manner, e.g. by grippers or rollers (not shown).

In one preferred embodiment in which the support surface 102 is sized to receive A4 and B4 size sheets, the tray is inclined at the following angles: A=2°, B=10° and C=12°. The orifices 110 are arranged one inch above the maximum intended stack height (0.3 inch) and aimed downwardly at angle of 25° to the horizontal to direct the flotation jets at the support surface 102, 4.5 inches from the end registration stop 104. Air is supplied at 100 litres/minute at a pressure of 4 millibars.

It will be understood that various changes and modifications may be made to the specific details referred to herein without departing from the scope of the invention as defined in the appended claims. For example, directional and/or retarding jets may additionally be provided in the embodiment of Figures 3 to 5 and in the embodiment of Figures 1 and 2, the tray may be tilted at a compound angle.

Further, although a guide 118 is shown in Figure 1 over the tray 101, in practice it has been found that the flotation jets tend, probably due to the Bernoull effect, to guide the sheets in a vertical sense and render such a guide unnecessary.

Claims

1. Apparatus for stacking sheets in corner registration on a support surface, in which sheets are delivered serially to the stack support surface and directed into a registration corner, said support surface defining a stack supporting area adjacent the registration corner and inclined in the direction of sheet travel, wherein means is arranged upstream of said stack supporting area and beneath the sheet delivery path to produce a flow of air over the stack supporting area at least partially to support each sheet being stacked during registration.

2. Apparatus according to Claim 1 in which the air flow is produced by a plurality of air jets issuing from orifices spaced across the sheet delivery path.

3. Apparatus according to Claim 2 in which the jets are shaped to produce a thin layer of air flowing across the stack supporting surface.

4. Apparatus according to Claim 3 in which the jets are aimed downwardly towards the support surface to impinge on the latter within the stack supporting area.

5. Apparatus according to Claim 1, 2, 3 or 4 in which the support surface is inclined downwardly at a compound angle towards the registration corner.

6. Apparatus according to Claim 5 in which the registration corner is defined by end and side registration stops and the support surface is inclined downwardly towards the end stop at an angle of between 7 and 20 degrees and is inclined downwardly towards the side stop at an angle of between 7 and 15 degrees.

7. Apparatus according to Claim 6 in which the angle at which the support surface is inclined towards the end stop is 12 degrees and the angle at which it is inclined towards the side stop is 10 degrees.

8. Apparatus according to claim 5, 6 or 7 in which the support surface is further skewed at an angle to the sheet delivery path.

9. Apparatus according to Claim 8 in which the skew angle of the support surface is between 2 and 10 degrees, preferably 2 degrees.

10. Apparatus according to any preceding claim in which one or more air jets are arranged aimed at and adjacent to the registration corner and/or registration edges to alleviate sheet bounce.

11. Apparatus according to any preceding claim including a retractable registration stop to permit removal of compiled sets from the stacking surface.

12. Apparatus according to Claim 11 in which the support surface is perforated with an array of apertures and means is provided for blowing air through said apertures during set removal to reduce the effects of friction.

13. Apparatus according to Claim 12, including an output tray for receiving sets ejected from the stack support surface.

14. Apparatus according to Claim 12, including at least one binding service device for binding sets compiled on the support surface.

15. In apparatus for stacking in corner registration on a support surface sheets delivered serially thereto, the support surface being inclined downwardly towards at least one of two registration stops defining a registration corner, a plurality of air jets arranged at the upper end of said surface beneath the sheet delivery path to direct air across said surface to assist in corner registration.

16. Apparatus according to Claim 15 in which at least said at least one stop is retractable.

17. Apparatus for stacking sheets in corner registration constructed, arranged and adapted to

operate substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

18. Apparatus for stacking sheets in corner registration constructed, arranged and adapted to operate substantially as hereinbefore described with reference to Figures 3 to 5 of the accompanying drawings.

19. A method for stacking sheets in corner registration on a support surface comprising delivering sheets serially to the support surface and directing the sheets into a registration corner, wherein air is directed from one or more positions upstream of the stack and beneath the sheet delivery path to form a cushion of air beneath each sheet as it is being conveyed onto the stack at least partially to support each sheet being stacked during registration.

20. Methods of stacking sheets in corner registration substantially as hereinbefore described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.